CERES SARB
On-line Fu-Liou
Radiative Transfer Code
Differential 200503 Version

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FuLiou Radiative Transfer Model

- Gamma weighted 2-stream (SW)*S.Kato* , 2/4 stream (LW)*Q.Fu*
  - Inhomogeneous clouds in SW
- 29 bands : 15 SW, 14 LW , 3 of 14 LW in WN
- Shortwave: (0.17 - 4.0)um (2500-57000cm-1)
  - Hitran 2000 (H20) (O_2,CO_2,CH_4) fixed : H_20 continuum
  - *JPL*(1994) O_3 uv , *WMO*(1985) O_3 vis
- Longwave (0-2850cm-1) (3.5um – infinity)
  - H_20 CO_2 O_3 N_20 CH_4 CFCs
  - H_20_Continuum(*Kratz&Rose)*
- Cloud Optical Properties Water (*Y.Hu*) Ice (*Q.Fu*)
- Aerosol optical properties
  - *OPAC, Tegin&Lacis, D'Almedia, Lacis(2004)Dust*

Uses

- Forcing cases
  - Cloud+aerosol (cloud & aerosol – pristine)
  - Cloud (cloud & aerosol – aerosol)
  - Aerosol (cloud & aerosol – cloud)
- Quick sensitivity studies
  - Partial differentials { case B minus case A}
  - Flux or radiance response to various input situations
- Tuning
  - Ceres Sarb constrainment
  - Impose TOA SW , LW, or window flux mismatch
  - Adjustments SkinT,Pw, surface albedo, aerosols, cloud (τ, z)

Online Fu Code Options

- Atmosphere options
  - Standard (tropical,MLS,MLW,SAS,saw)
  - Column PW ,O3 changes , skin temperature
  - User input of p(z),t(z),h_2o(z),o_3(z)
- Surface Radiative properties
  - Ocean Z. Jin COART surface albedo
  - Ceres SARB IGBP land type spectral albedos and emissivity
- Outputs
  - Table of broadband TOA and SURFACE , SW & LW
  - Vertical flux profiles (coarse 4 levels or fine 120 levels)
  - Spectral SW { TOA albedo , surface transmission,sfc albedo}
  - Spectral LW { TOA flux , surface flux }
  - Longwave anisotropy
  - Detailed but cryptic list of all inputs & outputs

Options (Cont.)

- Clouds
  - Fraction (ICA), optical depth, phase, particle size, top & base
  - Overlapped clouds allowed
  - Inhomogeniety : gamma distribution
    - shape param. $\nu = (\tau/\sigma)^2$
- Aerosols
  - Column optical depth (@0.63μ)
  - Constituent type determines spectral optical properties
  - Scale height assumption for vertical profile

Web Links

- On line Langley Fu-Liou Code
  - http://www-cave.larc.nasa.gov/rose/flp
- Ceres
  - http://asd-www.larc.nasa.gov/ceres/ASDceres.html
- Cave
  - http://www-cave.larc.nasa.gov/cave

No Web Access ?

- The following slides are examples of the actual web site outputs.

Fu-Liou Online 200503 (Differential Cases)

Input Controls

--> Compute <--

Case: A B

Forcing Cloud Aerosol Cld+Aer

Output: Profile / BB_Table / Spec_Toa_Alb

Atmosphere: MidLatSummer

Atmosphere EDIT No Simple Detail

Cosine Solar Zenith: 0.5

Cosine View Zenith: 1.0

#Streams 2 GWTSA 4

Surface Albedo: IGBP Spectral IGBP: 17 Ocean

Foam ON OFF Wind Speed: 5.0 Chlorophyll: 0.1

CO2(ppmv): 360.0 lw only

LW Continuum: 2.4_ckd

Surface Elevation (meters): 0.0

Vertical Resolution: LO HI

Cloud1

Fraction: 1.0

Optical Depth: 1.0

Presure(hPa) Top: 250. Bot: 300.

Phase WATER ICE

Size um: 60

Inhomgeniety (GWTSA): 100

Cloud2

Fraction: 0.0

Overlap Fraction(1&2): 0.0

Optical Depth: 10.0

Pressure(hPa) Top: 850. Bot: 900.

Phase WATER ICE

Size um: 20

Inhomgeniety (GWTSA): 100

Aerosols

Optical Depth 1: 0.20 Type: continental Scale Hgtkm: 4

Optical Depth 2: 0.00 Type: 0.5_dust_l2004 Scale Hgtkm: 1

Tune Case A : DOTUNE

Cloud and Aerosol Forcing Example

- Cloud (τ =1.0 ice d_e= 60.)+ Aerosol (Contnental τ =0.2)
- Pristine (no cloud , no aerosol) { only Rayleigh & gases}

CASE {A:Untuned} --> [PRISTINE] <-Vs-> [Cloud+Aerosol]						
Controll : [PRISTINE]	SHORTWAVE Flux Wm-2					
Perturbed :[Cloud+Aerosol]	TOA			SURFACE		
Cloud& Aerosol	[PRISTINE]	[Cloud+Aerosol]	Forced	[PRISTINE]	[Cloud+Aerosol]	Forced
Up	76.6	174.0	97.3	35.3	29.0	-6.3
Down	682.5	682.5	0.0	485.8	381.0	-104.8
NET	605.9	508.6	-97.3	450.5	351.9	-98.5
ALBEDO	0.112	0.255	0.143	0.073	0.076	0.003
Direct				439.6	158.4	-281.2
Diffuse				46.2	222.6	176.3
Direct FuIceCor				439.6	45.5	-394.1
Diffuse FuIceCor				46.2	335.5	289.2
	LONGWAVE Flux Wm-2					
Up	279.7	214.0	-65.6	422.4	422.5	0.1
Down	0.0	0.0	0.0	350.5	360.5	10.0
NET	-279.7	-214.0	65.6	-71.8	-62.0	9.8

2x Co_2

- Case A: CO_2 = 360 ppmv
- Case B: CO_2 =720 ppmv

Changes only applied in Longwave

CASE {B minus A} --> [PRISTINE] <-Vs-> [Cloud+Aerosol]						
Controll : [PRISTINE]	SHORTWAVE Flux Wm-2					
Perturbed :[Cloud+Aerosol]	TOA			SURFACE		
Cloud& Aerosol	[PRISTINE]	[Cloud+Aerosol]	Forced	[PRISTINE]	[Cloud+Aerosol]	Forced
Up	0.0	0.0	0.0	0.0	0.0	0.0
Down	0.0	0.0	0.0	0.0	0.0	0.0
NET	0.0	0.0	0.0	0.0	0.0	0.0
ALBEDO	0.000	0.000	0.000	0.000	0.000	0.000
Direct				0.0	0.0	0.0
Diffuse				0.0	0.0	0.0
Direct FuIceCor				0.0	0.0	0.0
Diffuse FuIceCor				0.0	0.0	0.0
	LONGWAVE Flux Wm-2					
Up	-3.1	-1.1	2.0	0.0	0.0	0.0
Down	0.0	0.0	0.0	1.5	1.2	-0.3
NET	3.1	1.1	-2.0	1.4	1.2	-0.3

Cloud Properties

CASE {A:Untuned} --> TOA Spectral Albedo (0-100)																
Sw Band um	.17:.22	.22:.24	.24:.28	.28:.29	.29:.32	.32:.35	.35:.43	.43:.49	.49:.59	.59:.70	.70:1.3	1.3:1.9	1.90:2.5	2.5:3.5	3.5:4.0	BB
[PRISTINE]	1.39	0.34	0.17	0.42	6.76	40.56	32.05	22.81	14.46	10.24	5.81	2.55	2.61	0.26	5.74	11.23
[Cloud+Aerosol]	1.39	0.34	0.17	0.42	7.24	47.21	43.33	37.10	29.91	27.08	23.51	14.31	11.16	2.01	5.10	25.49
Forcing	0.00	0.00	0.00	0.00	0.48	6.65	11.28	14.29	15.44	16.83	17.70	11.76	8.54	1.75	-0.65	14.26

2x Cloud Optical Depth (Tau:1.0 ◊ 2.0)

CASE {B minus A} --> TOA Spectral Albedo (0-100)																
Sw Band um	.17:.22	.22:.24	.24:.28	.28:.29	.29:.32	.32:.35	.35:.43	.43:.49	.49:.59	.59:.70	.70:1.3	1.3:1.9	1.90:2.5	2.5:3.5	3.5:4.0	BB
[PRISTINE]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
[Cloud+Aerosol]	0.00	0.00	0.00	0.00	0.31	3.60	5.51	6.67	7.18	7.98	9.65	6.18	4.00	0.46	-0.43	7.26
Forcing	0.00	0.00	0.00	0.00	0.31	3.60	5.51	6.67	7.18	7.98	9.65	6.18	4.00	0.46	-0.43	7.26

_ Cloud Particle Size (De: 60 ◊ 30.0)

CASE {B minus A} --> TOA Spectral Albedo (0-100)																
Sw Band um	.17:.22	.22:.24	.24:.28	.28:.29	.29:.32	.32:.35	.35:.43	.43:.49	.49:.59	.59:.70	.70:1.3	1.3:1.9	1.90:2.5	2.5:3.5	3.5:4.0	BB
[PRISTINE]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
[Cloud+Aerosol]	0.00	0.00	0.00	0.00	0.03	0.39	0.61	0.75	0.81	0.90	1.24	2.92	3.35	0.67	3.58	1.26
Forcing	0.00	0.00	0.00	0.00	0.03	0.39	0.61	0.75	0.81	0.90	1.24	2.92	3.35	0.67	3.58	1.26